Nuclear Stellar Kinematics of Hard X-ray Selected AGNs with Matched Inactive Galaxies

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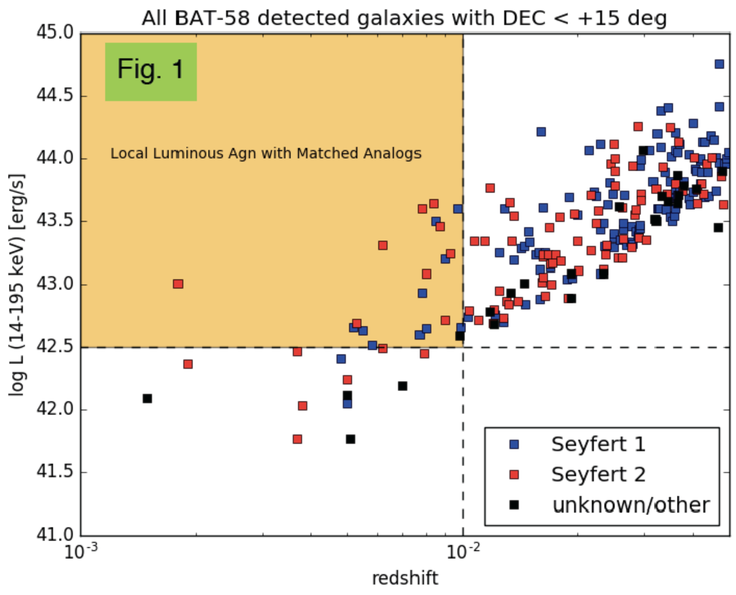
Abstract

In a matched sample of local, 14–195 keV selected active galactic nuclei (AGN) and inactive galaxies, we investigate the spatially resolved stellar kinematics and distributions on the scale of 10-300 pc. Here we present first results on part of the sample. We extract the observed stellar velocity fields and stellar velocity dispersion field of both AGNs and inactive galaxies. With larger scale 2MASS Ks band image, the disk, bar, and bulge have been decomposed. We find that there is a flux excess above the fitted bulge Sérsic profile in the innermost region. In the next step, we will search for evidence of dynamically cold nuclear stellar populations distinct from the bulge, and study the nuclear M/L_K ratios. The key goal of this project is to understand the role of nuclear star formation in the AGN fueling process.

Sample Selection – Local Luminous AGN with Matched Analogs (LLAMA)



(Fig. 1) A complete volume-limited sample, selected from Swift/BAT 58 month all-sky catalogue. This is generally accepted as the least biased way to select AGN purely on their intrinsic luminosity. The criteria are: X-ray luminosity > $10^{42.5}$; z < 0.01; declination <15° (Davies et al. 2015).

(Tab. 1) First half VLT SINFONI H+K band 100mas (FOV 3"×3") observations of the LLAMA sample. All targets have been extracted 2D kinematics maps of CO(2-0) 2.29μm stellar absorption. The detailed disk/bar/bulge decomposition has been studied with Pair 6 & Pair 8 (labeled as red).

Table 1

Pair	Name	Type	Host type	Bar	log(M*)	SINFONI K (mag)
1	ESO 1370-34	Seyfert 2	S0/a	X	10.4	11.90
	NGC 7727	Inactive	Sa	AB	10.4	10.80
2	NGC 7213	Seyfert 1 (LINER)	Sa	X	10.6	10.19
	NGC7727	Inactive	Sa	AB	10.4	10.80
3	NGC 7172	Seyfert 2	S0/a	X	10.4	10.12
	NGC 4224	Inactive	Sa	X	10.4	11.80
4	NGC 5728	Seyfert 2	Sb	B	10.5	11.55
	NGC 7727	Inactive	Sa	AB	10.4	10.80
5	NGC 7582	Seyfert 2	Sab	B	10.3	9.66
	NGC 4224	Inactive	Sa	X	10.4	11.80
6	NGC 3783	Seyfert 1.5	Sab	B	10.2	10.21
	NGC 718	Inactive	Sa	AB	9.8	11.18
7	NGC 4593	Seyfert 1	Sb	B	10.5	11.05
	NGC 3351	Inactive	Sb	B	10.0	11.55
8	NGC 6814	Seyfert 1.5	Sbc	AB	10.3	11.01
	NGC 4254	Inactive	Sc	X	10.2	11.99

Extracting the Kinematic Map of CO(2-0) 2.29μm Stellar Absorption and Measuring Position Angle (PA)

Method:

SINFONI IFU Data

↓ Using Penalized Pixel-Fitting (pPXF; Cappellari & Emsellem 2004): Gemini spectral templates have been convolved to SINFONI H+K spectral resolution, we used it as stellar library.

Extract Stellar CO kinematics 2D Map

↓

Fit kinematic PA — Cappellari et al. (2007) & Krajnovic et al. (2006)

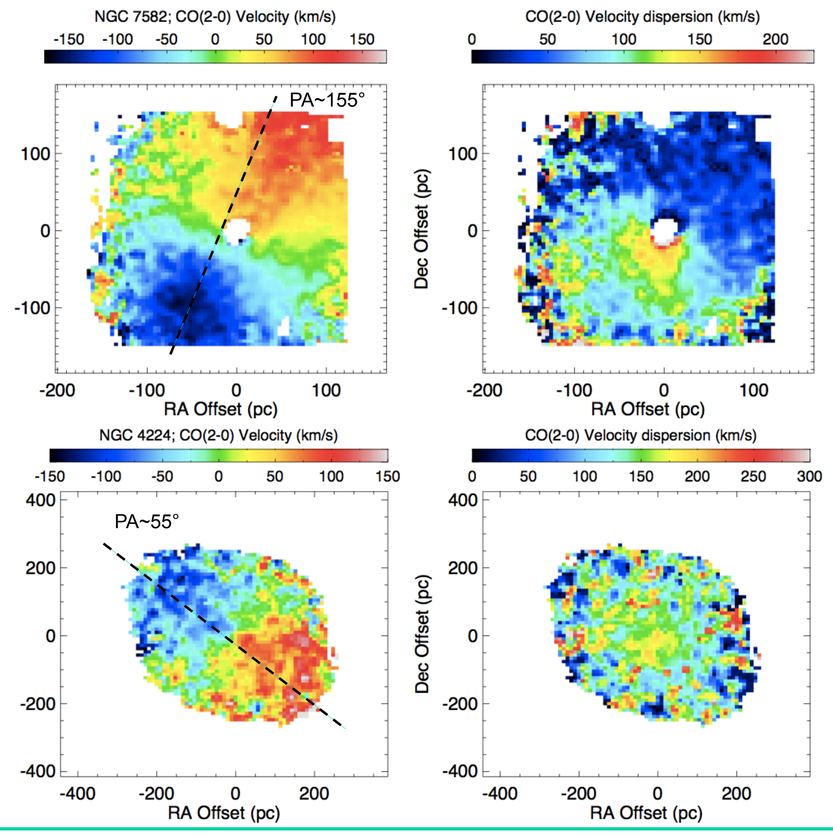
The kinematic PA measured from SINFONI is roughly consistent with the photometric PA derived from 2MASS image.

Results:

★ The stellar velocity and velocity dispersion map of ***Pair 5***: Active galaxy (Top: NGC 7582) and Inactive galaxy (Bottom: NGC 4224).

★ The dashed line is the fitted kinematic PA.

★ Both galaxies show a clear stellar rotation.



Decomposition and Nuclear Excess Flux

Method:

In order to look at whether there is an excess flux in the nucleus, we use larger scale 2MASS Ks band images to constrain the bulge Sérsic index(n_{bulge}) and effective radius(Re_{bulge}). In our fitting procedure, n_{disk} is fixed to 1, Re_{disk}, n_{bulge}, Re_{bulge} are free parameters. If a bar has been identified in the host galaxy, then we add a bar component.

2MASS GALFIT models:
Bulge + Disk
or
Bulge + Bar + Disk

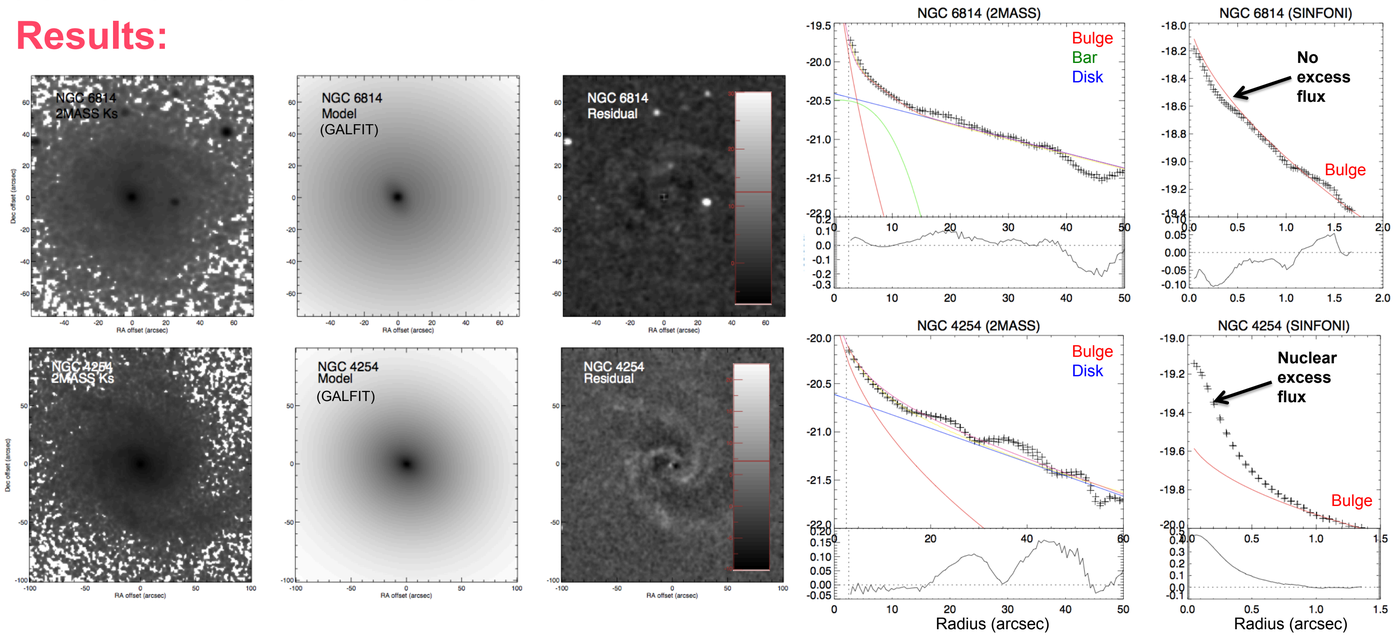
↓ Peng et al. 2002

Normalize bulge Sérsic profile to SINFONI 1D radial flux profile.

↓

Check whether there is an excess flux in the centre.

Results:



★ We present the 2MASS GALFIT result and SINFONI 1D stellar continuum radial profile of ***Pair 8***: Active galaxy (Top: NGC 6814) and Inactive galaxy (Bottom: NGC 4254).

★ We have analyzed ***Pair 6 & Pair 8***. Except NGC 6814 (Seyfert 1.5), other 3 galaxies show clear excess flux above the Sérsic fit to bulge in the innermost region, which can be explained as an additional inner component.

Summary of the Next Steps

This project is a work in progress; we plan to combine the flux profile and dispersion profile to simultaneously assess the evidence for a photometrically and kinematically distinct stellar population in the central tens of parsecs. With the observed velocity field, we can look for whether there is non-circular motion. We will also construct dynamical models with Jeans Anisotropic Models method (Cappellari et al. 2010). The M/L_K ratio can help us to constrain the age of the stellar population and understand whether BH accretion is associated with nuclear star formation.

References

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